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The invention relates to a method to the production from fine to microstructures and/or complex Mikrosystemen by layer-wise structure in and from a photo-curable liquid between two boundary surfaces, whereby the individual layers become corresponding masque formed by exposure of the liquid by one the layer topography through and the distance between the boundary surfaces successive around the respective layer thickness enlarged becomes, as well as an apparatus to the performing the method.

A such method and/or. a such apparatus is from the railways 44 20 999 C2 known. Assistance of the there disclosed technique is it possible to manufacture the above microstructures by finest film formation in excellent resolution.

Beyond that it is from US 5,143,817 A known to make integral three-dimensional objects of photo-curable layers whereby the layers become developed by a removable flexible transparent film through, whereby a side of the film is in contact with the curable liquid and the other side with a fixed transparent plate, which leads and holds the film.

With the help of the before-known technique it is however not possible to manufacture such microstructures in larger quantity since can become generated in each apparatus only in each case a microstructure.

Therefore the inventor in DE has 195 39 039 C2 a solution proposed, how a variety of structures can become simultaneous generated. On the basis of an apparatus after DE 44 20 996 C2 is here the radiation source a radiating express mechanism downstream, whereby the partial jets are directed on one of the plates next to each other on the liquid surface focussed parallel with this plate.

Thus parallel next to each other similar microstructures can become at the same time generated, whereby however the number of the structures which can be generated is still limited.

It is from the state of the art (DE 197 21 170 A1) known films structured with the help of the "rotary printing procedure" and/or. Films from thermoplastic to produce for radiation-curable plastics on a carrier film.

Finally it is from the WHERE 96/22874 A1 known, with the help of a rolling partial's pair, with which a roller light transmissive is and exhibits in their an inner light source, the pores of the surface of a thermoplastic porous film, which between the rollers passed, will close, whereby the surface of the porous material becomes heated, by the light radiation coming from the roller.

Thus it acts with these methods not around the layer-wise structure of microstructures, but around the thermal treatment of surfaces.

The invention is the basis the object to indicate a method and an apparatus with which/the arbitrary many microstructures in series of manufactured to become to be able.

The invention solves this object with the features the claim 1.

With the invention process exactly the same many pairs of rolls are in series one behind the other arranged like layers in the structures generated to become to be supposed in the extreme case. In addition, alternative one can be a pair of rolls, increased with which with each pass the distance becomes around the layer thickness, provided. The structure of the apparatus for the execution of this method resembles thereby known apparatuses from the printing technique. Accurate one as on the field of the printing technique the possible invention process arbitrary large "editions".

The photo-curable liquid can be only limited thereby similar as the above state of the art to the range between the two interfaces (in the nip). The invention process is feasible however also in a basin filled with the photo-curable liquid.

Differently than with the method in accordance with state of the art the structures on substrate transparency constructed must become, those with the component a larger adhesion are received than with that usually non-adhesive-end coated roller, by those the exposure of the liquid surface made. This roller becomes in the following exposure roller mentioned.

The exposure roller consists of one for electromagnetic waves (UV light, laser, etc.) permeable material such as z. B. Quartz glass. The generation of the respective layer in its desired topography is done thereby via a masque which represents that to negative ones of this topography. This masque can be either on the exposure roller applied, for example vapor deposited. Here too the chrome glass masque known from microelectronics offers itself, which can be present also in grey scale form, whereby by defined light permeability gradients for example also optical lenses generated to become to be able.

An alternative for this becomes seen in the fact that is arranged in the exposure roller between light source and roller surface a stationary exposure slot and the masque is as below the slit at the surface of the exposure roller led past foil strip formed. This exposure foil also for electromagnetic waves transmissive and impervious ranges in accordance with the layer topography which can be generated becomes synchronous with the substrate transparency between exposure roller and exposure slot guided.

The exposure slot depends thereby in its width on the rolling diameter, on the material which can be exposed and on the peripheral speed of the roller.

With the help of the invention process structures generated can become, those accurate defined physical, D by the use various curable liquids between the respective pairs of rolls. h. z. B electrical and/or. optical properties exhibit.

In order to be still more free with the generation of structures with most different properties, the invention process suggests that additional films with physical and/or chemical properties, which deviate from those of the cured layers parallel supplied between the rollers and with the upper layer and the subsequent layer bonded become; so z can. B. between the layers also electrical conductive layers constructed become. The coated films structured with electrical conductive materials become structured bonded thereby likewise by means of plastic polymerizable with electromagnetic waves. The bond becomes again by a masque or an alternative with the described above exposure foil realized mounted on the exposure roller.



In addition, the bond with the structure can become with other adhesion methods realized. For example by a film, which is coated with an adhesive, whereby this adhesive can become likewise structured applied, by taking over the coating techniques of the offset printing.

Up or introduced films can realize also different functions. Like that it is more conceivable, the elasticity of in and/or. to use applied film concerning their spring action. Further it is more conceivable to use films with special magnetic or chemical properties (basic, neutral, acidic, hydrophilic or hydrophobic) targeted.

With an other favourable embodiment of the invention is provided that between a pair of rolls generated the layer in a subsequent step to the removal of the not cured substance rinsed will and in a subsequent pair of rolls a replenishment of the ranges by materials, freed of not the cured substance, or finished components with different physical, chemical and/or biological properties performed becomes.

If the ranges freed of the not cured substance become filled by another substance, this substance can become also by other hardening by precipitation mechanisms cured, z. B. by deoxidation, evaporation of solvents or warm ones.

Here it is every now and then required that becomes connected after the cleaning operation (rinsing procedure) a drying process. If components become supplied, then this can take place by means of the fact that they become adhesive similar on a film as a described already above pair of rolls supplied. The components become freed into like the described above generated cavities inserted by means of structured bond fixed and at a so called peeling roller by formwork of their original carrier.

An other advantage of the invention process is to be seen in the fact that the microstructures or systems in simple manner processed, produced in measures, to become to be able, there the structures on the substrate sheet in high order, alignment of the layer and distance of the components be present, whereby this order during the subsequent treatment z. B. by supply of gegurteter components exploited will can.

With the help of the invention-towards-measured method it is however not only possible structures discrete on the substrate sheet and/or. Components to generate, it can become also microstructured films themselves beyond that generated, whereby either on the film a structured surface generated can become (Lotosblumeneffekt, shark fish skin, or films for flat screens) or however in itself microstructured films, whereby becomes again remote after the job of this microstructure on the carrier film subsequent this carrier film.

In the last pair of rolls for example the structures with an adhesive film can become coated, which should be with the transport and designed before the subsequent treatment as package to the protection against outside influences.

The invention becomes in the following on the basis from designs shown and more near explained.

Show:

Fig. 1 pair of rolls with the generation of a first substrate layer,

Fig. 2 pair of rolls in accordance with Fig. 1 with mask foil,

Fig. 3 pair of rolls with the generation of the second layer,

Fig. 4 pair of rolls and feeding device of components which can be inserted,

Fig. 5 pair of rolls with supply of a film.

Into the Fig. 1 to 5 is provided a pair of rolls shown and general with the reference numeral 1 in each case. For the apparatus according to invention one must imagine n of these pairs of rolls in series to each other switched, whereby n is dependent from the structure-high and/or. of the properties, which a such structure is to have. In addition, alternative one can be a pair of rolls provided, increased with which with each pass the distance of the rollers becomes around the layer thickness.

In the Fig. 1 is the first pair of rolls 1 within the apparatus shown. It exists (like in principle the other pairs of rolls also) from one out for electromagnetic waves permeable material existing exposure roller 2 and a counter roller 3, which leave a nip 4 between itself. In the exposure roller 2 is electromagnetic waves sending sources 5 (UV source, laser etc.) arranged. Between light source 5 and the nip 4 a stationary exposure slot 6 is in the roller 2. By the nip passed becomes a substrate transparency 7, is 8 provided between which and the exposure roller 2 a photo-curable liquid held by adhesive forces. On the surface of the exposure roller 2 a masque (for example chrome glass masque) is applied, which a negative one represents to the layer topography of the first layer which can be produced.

The liquid 8 becomes 6 exposed with the help of the light source 5 by the exposure slot. Where the light into the liquid to penetrate can (D. h. by the masque), the polymerized liquid is not faded out and becomes fixed. Thereby the first layer 9 of the structure which can be generated develops.

In the Fig. 2 is an actual same apparatus shown. Here the masque is on the surface of the exposure roller 2 however applied not, but becomes in mould of an exposure foil 10 between exposure slot and liquid surface passed.

In the Fig. 3 is in the Fig. 1 and 2 represented pair of rolls 1 downstream pair of rolls 1' shown, by which the second layer becomes 9' on the first layer 9 in same way generated as related in Fig. 1 and 2 described. In addition, the substance to the generation of the second layer 9' can thereby same be as the substance of the first layer 9, can of other material with different properties consist.

In the Fig. 4 is again a pair of rolls 1'' shown, at which already with a trough provided generated structures 11 arrive before and become there also from a coil 12 supplied (for example) components 13 equipped. The components 13 cling on a film 14. After the insertion of the components 13 into the troughs of the structure 11 this by means of peeling measurers become 16 by the film 14 peeled. Fastening the parts 13 in the troughs adhesion methods applied can become, at which likewise with photo-curable substances one works, in the way like described above.

Finally is in Fig. 5 a final pair of rolls 1''' shown, 15 covered in which the finished structures 11 become the protection and the transport with a cover sheet. Also here a bond of the film with the structures 11 can take place by means of the above method.

Dependent ones of chemikalischen, physical and biological properties can do similar as in Fig. 5 shown also with production, D. h. with the generation of the structures 11 films supplied become, which form then individual layers of the structure.